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मानक

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IS/IEC 61241-18 (2004): Electrical apparatus for use in the presence of combustible dust, Part 11: Protection by encapsulation 'mD' [ETD 22: Electrical Apparatus for Explosive Atmosphere]



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“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

दहनशील धूल की उपस्थिति में प्रयोग होने वाले विद्युत के उपस्कर

भाग 18 प्राकरण "mD" द्वारा सुरक्षा

Indian Standard

**ELECTRICAL APPARATUS FOR USE IN THE
PRESENCE OF COMBUSTIBLE DUST**

PART 18 PROTECTION BY ENCAPSULATION "mD"

ICS 29.260.20

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Electrical Apparatus for Explosive Atmospheres Sectional Committee, ETD 22

NATIONAL FOREWORD

This Indian Standard (Part 18) which is identical with IEC 61241-18 : 2004 Electrical apparatus for use in the presence of combustible dust — Part 18: Protection by encapsulation “mD” issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Apparatus for Explosive Atmospheres Sectional Committee and approval of the Electrotechnical Division Council.

The text of the IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as ‘Indian Standard’.
- b) Comma (,) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
IEC 60079-7 : 2001 Electrical apparatus for explosive gas atmospheres — Part 7: Increased safety “e”	IS 6381.: 2004 Electrical apparatus for explosive gas atmospheres — Increased safety “e” (<i>first revision</i>)	Identical
IEC 60079-11 : 1999 Electrical apparatus for explosive gas atmospheres — Part 11: Intrinsic safety “i”	IS 5780 : 2002 Electrical apparatus for explosive gas atmospheres — Intrinsic safety “i” — Specification (<i>second revision</i>)	do
IEC 60086-1 Primary batteries — Part 1: General	IS 6303 : 1984 General requirements and methods of tests for dry cells and batteries (<i>first revision</i>)	Technically Equivalent
IEC 60127-1 Miniature fuses — Part 1 : Definition for miniature fuses and general requirements for miniature fuse links — Specification	IS/IEC 127-1 : 1988 Miniature fuses: Part 1 Definition for miniature fuses and general requirements for miniature fuse links — Specification	do
IEC 60127-2 Miniature fuses — Part 2 : Cartridge fuse links — Specification	IS/IEC 127-2 : 1989 Miniature fuses: Part 2 Cartridge fuse links — Specification	do
IEC 60127-6 Miniature fuses — Part 6 : Fuse holders for miniature cartridge fuse links — Specification	IS/IEC 127-6 : 1994 Miniature fuses: Part 6 Fuse holders for miniature cartridge fuse links — Specification	do

<i>International Standard</i>	<i>Title</i>
IEC 61436 : 1998	Secondary cells and batteries containing alkaline or other non-acid electrolytes — Sealed nickel-metal hydride rechargeable single cells
IEC 61960-1 : 2003	Secondary lithium cells and batteries for portable applications — Part 1: Secondary lithium cells
IEC 62326-4-1 : 1996	Printed boards — Part 4: Rigid multilayer printed boards with interlayer connections — Sectional specification — Section 1: Capability detail specification — Performance levels A, B and C
ANSI/UL 248-1	Standard for low-voltage fuses — Part 1: General requirements
ANSI/UL 746B	Polymeric materials — Long-term property evaluations

Only the English language text has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in the IEC Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

INTRODUCTION

Many dusts which are generated, processed, handled and stored, are combustible. When ignited they can burn rapidly and with considerable explosive force if mixed with air in the appropriate proportions. It is often necessary to use electrical apparatus in locations where such combustible materials are present, and suitable precautions must therefore be taken to ensure that all such apparatus is adequately protected so as to reduce the likelihood of ignition of the external explosive atmosphere. In electrical apparatus, potential ignition sources include electrical arcs and sparks, hot surfaces, and frictional sparks.

Areas where dusts, flyings and fibres in air occur in dangerous quantities are classified as hazardous and are divided into 3 zones according to the level of risk.

Generally, electrical safety is ensured by the implementation of one of two considerations, i.e. that electrical apparatus be located where reasonably practicable outside hazardous areas and that electrical apparatus be designed, installed and maintained in accordance with measures recommended for the area in which the apparatus is located.

Combustible dust can be ignited by electrical apparatus in several ways:

- by surfaces of the apparatus that are above the minimum ignition temperature of the dust concerned. The temperature at which a type of dust ignites is a function of the properties of the dust, whether the dust is in a cloud or layer, the thickness of the layer and the geometry of the heat source;
- by arcing or sparking of electrical parts such as switches, contacts, commutators, brushes, or the like;
- by discharge of an accumulated electrostatic charge;
- by radiated energy (for example, electromagnetic radiation);
- by mechanical sparking or frictional sparking or heating associated with the apparatus.

In order to avoid ignition hazards it is necessary that

- the temperature of surfaces, on which dust can be deposited, or which would be in contact with a dust cloud, is kept below the temperature limitation specified in this standard;
- any electrical sparking parts, or parts having a temperature above the temperature limit specified in IEC 61241-14
 - are contained in an enclosure which adequately prevents the ingress of dust, or
 - the energy of electrical circuits is limited so as to avoid arcs, sparks or temperatures capable to ignite combustible dust;
- any other ignition sources are avoided.

Compliance with this standard will only provide the required level of safety if the electrical apparatus is operated within its rating and is installed and maintained according to the relevant codes of practice or requirements, for example in respect of protection against over-currents, internal short-circuits, and other electrical faults. In particular, it is essential that the severity and duration of an internal or external fault be limited to values that can be sustained by the electrical apparatus without damage.

Several techniques are available for the explosion protection of electrical apparatus in hazardous areas. This standard describes the safety features of these types of explosion-protection techniques and specifies the installation procedures to be adopted. It is most important that the correct selection and installation procedures be followed to ensure the safe use of electrical apparatus in hazardous areas.

*Indian Standard***ELECTRICAL APPARATUS FOR USE IN THE
PRESENCE OF COMBUSTIBLE DUST****PART 18 PROTECTION BY ENCAPSULATION "mD"****1 Scope**

This standard is to be read in conjunction with IEC 61241-0, the requirements of which apply to electrical apparatus protected by encapsulation and surface temperature limitation unless specifically excluded.

This part of IEC 61241 is applicable to electrical apparatus protected by encapsulation type of protection "mD" and surface temperature limitation for use in areas where combustible dust may be present in quantities which could lead to a fire or explosion hazard. It specifies requirements for design, construction and testing of electrical apparatus, parts of electrical apparatus and Ex components where the rated voltage does not exceed 10 kV.

NOTE 1 The actual working voltage may exceed the value given above by up to 10 %.

NOTE 2 IEC 61241-14 ("Electrical apparatus for use in the presence of combustible dust – Part 14: Selection and installation") gives guidance on the selection and installation of the apparatus. Apparatus within the scope of this standard may also be subjected to additional requirements in other standards – for example, IEC 60079-0 ("Electrical apparatus for explosive gas atmospheres – Part 0: General requirements").

The application of electrical apparatus in atmospheres which may contain explosive gas as well as combustible dust, whether simultaneously or separately, requires additional protective measures.

This standard does not apply to dusts of explosives which do not require atmospheric oxygen for combustion, or to pyrophoric substances.

This standard is not applicable to electrical apparatus intended for use in underground parts of mines as well as those parts of surface installations of such mines endangered by firedamp and/or combustible dust. This standard does not take account of any risk due to an emission of flammable or toxic gas from the dust.

This standard does not include other types of protection and is only applicable to protection by encapsulation.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60079-7:2001, *Electrical apparatus for explosive gas atmospheres – Part 7: Increased safety "e"*

IEC 60079-11:1999, *Electrical apparatus for explosive gas atmospheres – Part 11: Intrinsic safety "i"*

IEC 60086-1, *Primary batteries – Part 1: General*

IEC 60127 (all parts), *Miniature fuses*

IEC 60243-1, *Electrical strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60285, *Alkaline secondary cells and batteries – Sealed nickel-cadmium cylindrical rechargeable single cells*²

IEC 60622, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-cadmium prismatic rechargeable single cells*

IEC 60664-1:1992, *Insulation co-ordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*
Amendment 1 (2000)
Amendment 2 (2002)

IEC 60691, *Thermal links – Requirements and application guide*

IEC 61150, *Alkaline secondary cells and batteries – Sealed nickel cadmium rechargeable monobloc batteries in button cell design*

IEC 61241-0:—, *Electrical apparatus for use in the presence of combustible dust – Part 0: General requirements*

IEC 61241-1:—, *Electrical apparatus for use in the presence of combustible dust – Part 1: Protection by enclosures “tD”*

IEC 61241-11:—, *Electrical apparatus for use in the presence of combustible dust – Part 11: Protection by intrinsic safety “iD”*³

IEC 61436, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-metal hydride rechargeable single cells*⁴

IEC 61558-2-6, *Safety of power transformers, power supply units and similar – Part 2: Particular requirements for safety isolation transformers for general use*

IEC 61960-1, *Secondary lithium cells and batteries for portable applications – Part 1: Secondary lithium cells*

IEC 62326-4-1, *Printed boards – Part 4: Rigid multilayer printed boards with interlayer connections – Sectional specification – Section 1: Capability detail specification – Performance levels A, B and C*

ISO 62, *Plastics – Determination of water absorption*

ANSI/UL 248-1, *Standard for low-voltage fuses – Part 1: General requirements*

ANSI/UL 746B, *Polymeric Materials – Long-term Property Evaluations*

² Cancelled and replaced by IEC 61951-1 (2003).

³ To be published.

⁴ Cancelled and replaced by IEC 61951-2 (2003).

3 Terms and definitions

For the purposes of this document, the following terms and definitions, specific to protection by encapsulation "mD", apply. They supplement the definitions given in IEC 61241-0.

3.1

encapsulation "mD"

type of protection whereby parts that are capable of igniting an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way as to avoid ignition of a dust layer or cloud under operating or installation conditions

3.2

compounds

any thermosetting, thermoplastic, epoxy resin or elastomeric materials with or without fillers and/or additives, in their solid state

3.3

temperature range of the compound

the range of temperatures within which the properties of the compound, in either operation or storage, permit compliance with the requirements of this standard

3.4

continuous operating temperature (COT) of the compound

the temperature within which, according to the details given by the manufacturer, the properties of the compound, during operation, satisfy the requirements of this standard on a permanent basis during the foreseen lifetime of the apparatus

3.5

encapsulation

the process of applying the compound to enclose any electrical device(s) by suitable means

3.6

free surface

compound surface exposed to the explosive atmospheres

3.7

normal operation

the operation of apparatus conforming electrically and mechanically with its design specification and used within the limits specified by the manufacturer

NOTE 1 The limits specified by the manufacturer may include persistent operational conditions, for example, operation of a motor on a duty cycle.

NOTE 2 Variation of the supply specifications within stated limits and any other operational tolerance is part of normal operation.

3.8

void

unintentional space created as a consequence of the encapsulation process

3.9

free space

intentionally created space surrounding components or space inside components

3.10

switching contact

mechanical contact which is intended for making and breaking of an electrical circuit

4 General

4.1 Temperature classification

Encapsulation "mD" apparatus shall be classified in accordance with Clause 5 of IEC 61241-0.

4.2 Level of protection

Electrical apparatus with encapsulation "mD" shall be either level of protection "maD" or level of protection "mbD".

The requirements of this standard shall apply to both levels of protection unless otherwise stated.

If a non-resetting protective device, according to IEC 60127 or IEC 60691, is used, then only one device is necessary for both levels of protection.

4.3 Level of protection "maD"

Level of protection "maD" shall not be capable of causing ignition in each of the following circumstances.

- a) in normal operation and installation conditions;
- b) any specified abnormal conditions;
- c) in defined failure conditions.

For level of protection "maD" the working voltage at any point in the encapsulation circuit shall not exceed 1 kV.

For level of protection "maD", components without additional protection shall only be used if they cannot damage the encapsulation mechanically or thermally in the case of any fault.

Alternatively, where a fault of an internal component may lead to failure of the encapsulation system due to increasing temperature, the requirements of 6.2 shall apply.

NOTE Certain components whose application is allowed according to this standard for level of protection "mbD" can possibly make the protective measure 'encapsulation' ineffective by mechanical or thermal damage as a consequence of internal reactions. This risk should be excluded for level of protection "maD" apparatus.

4.4 Level of protection "mbD"

Level of protection "mbD" shall not be capable of causing ignition in each of the following circumstances.

- a) in normal operation and installation conditions;
- b) in defined failure conditions.

4.5 Supply specifications

The limiting values of the supply (rated voltage and the prospective short circuit current) shall be stated to ensure that under the relevant level of protection, "maD" or "mbD", the limiting temperature is not exceeded. Any protective device used shall comply with the requirements of 7.7.

5 Requirements for compounds

5.1 General

The documentation in accordance with 23.2 of IEC 61241-0 shall specify the compound(s) used and the processing method(s).

As a minimum, those properties of the compound(s) on which the encapsulation "mD" depends shall be provided.

Due consideration shall be taken in the selection of encapsulating materials to allow for the expansion of components during operation and in the event of allowable faults.

5.2 Specification

The manufacturer shall attest on his own responsibility that the material complies with the compound specification.

The specification shall include:

- a) the name and address of the manufacturer of the compound;
- b) the exact and complete reference of the material, and, if relevant, percentage, of fillers and any other additives, the mixture ratios and the type designation;
- c) if applicable, any treatment of the surface of the compound(s), for example, varnishing;
- d) if applicable, to obtain correct adhesion of the compound to a component, any requirement for pre-treating of the component, for example, cleaning, etching;
- e) if appropriate, the result of the water absorption test in accordance with 8.1. Where this test has not been performed, the apparatus shall be marked "X" in accordance with item I) of 29.2 of IEC 61241-0;
- f) the dielectric strength in accordance with IEC 60243-1 at the maximum temperature of the apparatus determined according to 8.2.2;
- g) temperature range of the compound(s) (upper and lower continuous operating temperature);
- h) in the case of encapsulation "mD" apparatus where the compound is part of the outside enclosure, the temperature index TI value as defined in 6.1.4 of IEC 61241-0. As an alternative to the TI, the Relative Thermal Index (RTI-mechanical impact) may be determined in accordance with ANSI/UL 746B;
- i) the colour of the compound used for the test samples where the compound specification will be influenced by changing the colour.

6 Temperatures

6.1 General

The maximum surface temperature and the maximum value of the continuous operating temperature of the compound shall not be exceeded during normal operation. The encapsulation "mD" apparatus shall be protected in such a way that the encapsulation "mD" is not affected under specified fault conditions.

6.2 Temperature limitation

When a protective device is required to limit temperatures for safety reasons, it shall be a non-resetting internal or external, electrical or thermal device. One device is required for level of protection "mbD" and two devices for level of protection "maD". The thermal coupling of the device to the component being monitored shall be sufficient. For functional reasons the "mD" apparatus may also contain an additional resettable protective device.

If the non-resetting protective device complies with IEC 60127 or IEC 60691, only one device is necessary for both levels of protection.

Where the apparatus may be subject to fault, see 7.2.1, or where there is the possibility of an increased temperature, for example by an unfavourable input voltage in accordance with 7.2.1 or an unfavourable load, these shall be taken into account in determining the limiting temperature.

6.3 Determination of the limiting temperature values

6.3.1 Maximum surface temperature

The maximum surface temperature shall be determined using the test method given in 8.2.2 in accordance with the supply conditions specified in 4.5.

6.3.2 Temperature of the components in the compound

The hottest component(s) shall be determined. The maximum temperature in the compound, adjacent to the hottest component(s), shall be determined using the test method given in 8.2.2 for normal operation.

NOTE The determination of the hottest component may be done by calculation or manufacturer's specification or by a practical test prior to encapsulating the components

7 Constructional requirements

7.1 General

Where the encapsulation forms part of the external enclosure it shall comply with the requirements for non-metallic enclosures and parts of non-metallic enclosures.

If additional protective measures are required by the user in order to satisfy the requirements of this standard, for example, additional mechanical protection, to indicate this special condition of use, the apparatus shall be marked "X" in accordance with item l) of 29.2 of IEC 61241-0.

Appropriate action shall be taken to accommodate the expansion of components during normal operation and in the event of faults according to 7.2.

In 7.2 to 7.7 the requirements differ according to whether the compound adheres to the enclosure. Where adhesion is specified the aim is to prevent the ingress of combustible dust and moisture at the boundary surfaces (for example, enclosure – compound, compound – parts that are not completely embedded in the compound, such as printed wiring boards, connections terminals, etc.). If additional treatment for the boundary surfaces is required in order to ensure adhesion, this shall be included in the manufacturer's documentation.

Where adhesion is specified, it shall be maintained after completion of all the prescribed tests.

NOTE The choice of the compound(s) to be used for a specific application is dependent on the task each compound has to perform. In general, testing a compound once is not sufficient for universal use for encapsulation "mD".

7.2 Determination of possible faults

7.2.1 Fault examination

The encapsulation protection shall be maintained even in the case of an unfavourable input condition (but between 90 % and 110 % of the rated parameter) and unfavourable output load and of any internal electrical fault (two faults for level of protection "maD" and one fault for level of protection "mbD"), for example, in the event of

- a short circuit in any component;
- the failure of any component;
- a fault in the printed circuitry..

Infallible components and infallible separation distances shall not be subject to fault.

If a fault leads to one or more subsequent faults, for example, due to the overload of a component, the primary and subsequent fault(s) are considered to be a single fault.

7.2.2 Infallible components

The following components shall be considered to be infallible if they are encapsulated according to the requirements of this standard, are suitable for the temperature range at the site of installation and if they are not loaded with more than 2/3 of their rated voltage, rated current and rated power specified by the manufacturer of the respective component:

- resistors, if they comply with 8.4 of IEC 60079-11,
- single-layer, spirally wound coils,
- plastic foil capacitors,
- paper capacitors,
- ceramic capacitors,
- semiconductors, if they are used in accordance with 8.6 of IEC 60079-11.

Where semiconductor devices are used to limit current, a single device is adequate for level of protection "mbD" but two devices shall be used for level of protection "maD".

NOTE In contrast to the requirements for intrinsically safe apparatus with level of protection "laD" according to IEC 61241-11, it is not necessary to prohibit the use of active semiconductor regulating circuits, as the effect of a short term transient disturbance is significantly less for encapsulated apparatus.

The following components for the segregation of different circuits shall be considered infallible.

- a) Optocouplers and relays, if the rated insulation voltage conforms to $(2U + 1\,000\text{ V})$ or $1\,500\text{ V a.c.}$ whichever is greater (U is the sum of the rated r.m.s. voltages of both circuits).
- b) Transformers, complying with IEC 61558-2-6 or IEC 61241-11.
- c) Coils, transformers and motor windings that comply with IEC 60079-7, including those that have wire diameters of less than 0,25 mm when they are also protected against inadmissible internal temperatures, are considered infallible.

7.2.3 Infallible separation distances

It is not necessary to consider the possibility of a fault occurring as described in 7.2.1 in respect of voltage breakdown, if the distances between bare current-carrying parts

- of the same circuit, or
- of a circuit and earthed metal parts, or
- of two separate circuits (sum of voltages shall be taken as the voltage for Table 1; where one of the working voltages is less than 20 % of the other, it shall be ignored),

comply with the requirements of 7.2.3.1 and if applicable 7.2.3.2.

7.2.3.1 Distances through the compound

Distances through compound shall be considered to be infallible if they comply with the values in Table 1, provided that they were fixed mechanically before encapsulation.

Table 1 Distances through the compound

Voltage (see Note) U r.m.s. or d.c., V	Minimum distance mm
≤ 63	0,5
≤ 400	1
≤ 500	1,5
≤ 630	2
≤ 1 000	2,5
≤ 1 600	4
≤ 3 200	7
≤ 6 300	12
≤ 10 000	20
NOTE Voltages shown are derived from IEC 60664-1. For all voltages, the actual voltage may exceed the value given in the table by up to 10 %. This is based on the rationalisation of supply voltages given in Table 3b of IEC 60664-1.	

7.2.3.2 Distances through solid insulation

Distances through solid insulation shall be considered to be infallible if the minimum thickness of solid insulation is 0,1 mm and meets the dielectric strength test of 8.2.4.

7.2.4 Thickness of the compound

If the surface of the compound is totally or partly surrounded by an enclosure and the enclosure is part of the protection, the enclosure or parts of the enclosure shall comply with the enclosure requirements of IEC 61241-1.

The minimum thickness of the compound with or without a surrounding enclosure shall comply with the requirements of 7.2.5 to 7.2.7 as applicable.

In all cases the encapsulant is additionally subjected to the dielectric strength test of 8.2.4.

7.2.5 Encapsulation "mD" apparatus with free surface

The thickness of the compound between the free surface of the compound and the components or conductors in the encapsulation, as shown in Figure 1, shall comply with Table 2.

Table 2 – Thickness of compound between the free surface of the compound and components or conductors

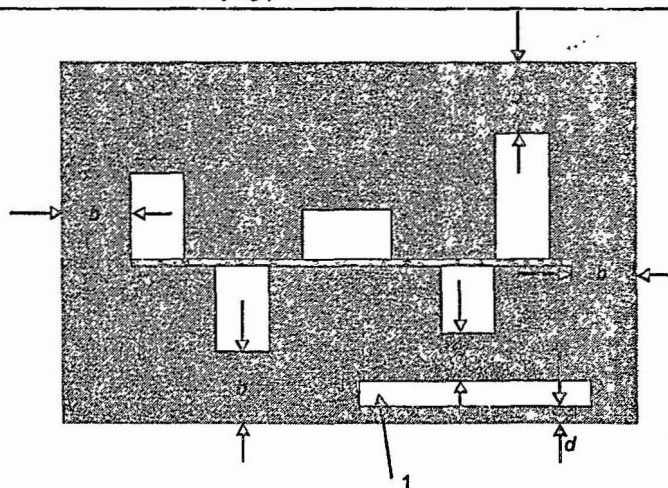
Level of protection "mD"	Level of protection "m5D"
$b \geq 3 \text{ mm}$	Free surface $< 2 \text{ cm}^2$ $b \geq$ distance according to Table 1, but not less than 1 mm
	Free surface $> 2 \text{ cm}^2$ $b \geq$ distance according to Table 1, but not less than 3 mm
$c \geq$ distance according to Table 1	$c \geq$ distance according to Table 1
$d \geq 3 \text{ mm}$	$d \geq 1 \text{ mm}$

where

b is the distance between the component and the free surface;

c is the distance between the component and non current-carrying parts inside the encapsulation;

d is the distance between a non current-carrying part and the free surface.



Key

1 Non current-carrying part

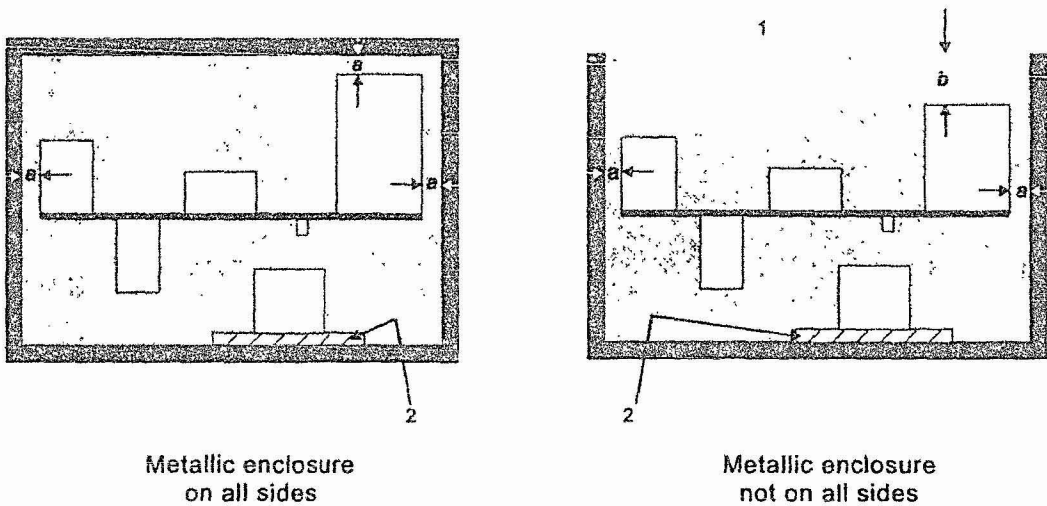
Figure 1 – Distances between free surface of compound and components or conductors

7.2.6 Encapsulation "mD" apparatus with metal enclosure

The thickness of the compound between the wall or the free surface of the compound and the components or conductors in the encapsulation, as shown in Figure 2, shall comply with Table 3.

Table 3 – Thickness of the compound between the wall or the free surface of the compound and the components or conductors

Level of protection "maD"	Level of protection "mbD"
$a \geq 3 \text{ mm}$	$a \geq 1 \text{ mm}$
$b \geq 3 \text{ mm}$	$b \geq \text{distance in accordance with Table 1, but not less than 3 mm}$
where a is the distance between the component and the enclosure; b is the distance between the component and the free surface	



Key

1 Free surface

2 Solid insulation material (see 7.2.3.2)

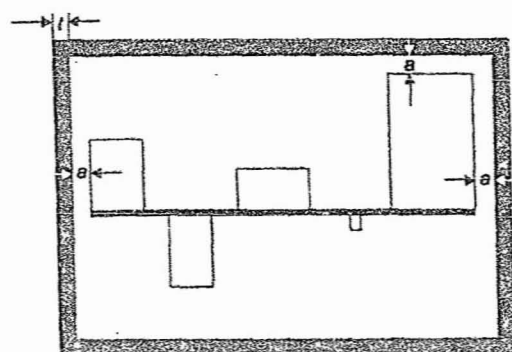
Figure 2 – Distances between the wall or the free surface of the compound and the components or conductors

7.2.7 Encapsulation "mD" apparatus with plastic enclosure

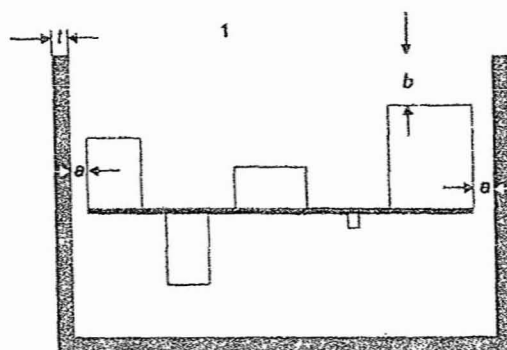
The thickness of the compound between the wall or the free surface of the compound and the components or conductors in the encapsulation are shown in Figure 3 and shall comply with Table 4.

Table 4 – Thickness of the compound between the wall or the free surface of the compound and the components or conductors

Enclosure with adhesion to the compound				Enclosure without adhesion to the compound			
$t < 1 \text{ mm}$		$t \geq 1 \text{ mm}$		$t < 1 \text{ mm}$		$t \geq 1 \text{ mm}$	
Level of protection "maD"	Level of protection "mbD"	Level of protection "maD"	Level of protection "mbD"	Level of protection "maD"	Level of protection "mbD"	Level of protection "maD"	Level of protection "mbD"
$a \geq 3 \text{ mm}$	$a \geq 1 \text{ mm}$	$a + t \geq 3 \text{ mm}$	$a + t \geq 1 \text{ mm}$	$a \geq 3 \text{ mm}$	$a \geq 3 \text{ mm}$	$a \geq 3 \text{ mm}$	$a \geq 1 \text{ mm}$
$b \geq \text{distance in accordance with Table 1, but not less than } 3 \text{ mm}$							
where							
a is the distance between the component and the enclosure;							
b is the distance between the component and the free surface;							
t is the wall thickness.							



Plastic enclosure
on all sides



Plastic enclosure
not on all sides

Key

1 Free surface

Figure 3 – Distances between the wall or the free surface of the compound and the components or conductors

7.2.8 Windings for rotating machines

For electrical machines with windings in slots, the solid slot insulation shall have

- for level of protection "maD" a minimum thickness of 0,1 mm and shall be extended by at least 5 mm beyond the slot;
- for the level of protection "mbD", no requirement for minimum thickness or extension.

For both levels of protection "maD" and "mbD" the end of the slot and the end-winding shall be protected by the minimum thickness of compound in accordance with 7.2.4. An electric strength test shall be passed with $U = (2U + 1\,000 \text{ V})$ a.c. with a minimum of 1 500 V a.c.

7.2.9 Rigid, multi-layer printed wiring boards with through connections**7.2.9.1 General**

Multi-layer printed wiring boards complying with the requirements of IEC 62326-4-1, performance level C, with the minimum distances in 7.2.9.2 and operated at voltages less than or equal to 500 V shall be considered to be encapsulated provided they meet the following clauses.

7.2.9.2 Minimum distances

The insulation of the copper-clad laminates (cores) and the adhesive films shall comply with the requirements of 7.2.3.2.

The minimum distance between the printed circuit conductors and the edge of the multi-layer printed wiring board or any hole in it shall be at least 3 mm. If the edges or holes are protected with metal or insulating material extending at least 1 mm along the surface of the board from the edge/hole, the distance of the printed wiring conductors may be reduced to 1 mm. Insulating material shall comply with the requirements for conformal coating in accordance with IEC 61241-11. Metal coating shall have a minimum thickness of 35 μm , see also Figure 4 and Table 5.

Table 5 – Minimum distances for multi-layer printed wiring boards

Distance	Level of protection "maD"	Level of protection "mbD"
<i>a</i>	3 mm	0,5 mm
<i>b</i>	3 mm	3 mm
<i>c</i>	3 mm	1 mm
<i>d</i>	0,1 mm (see 7.2.3.2)	0,1 mm (see 7.2.3.2)
<i>e</i>	Distances in accordance with Table 1	Distances in accordance with Table 1
where: <i>a</i> is the distance between the current-carrying part and the outside surface through the cover layer; <i>b</i> is the distance between the current-carrying part and the outside surface along the cover layer; <i>c</i> is the length of metal or insulation extending along the surface of the board from the edge or the hole; <i>d</i> is the thickness of the adhesive film or the core; <i>e</i> is the distance between two circuits inside the multilayer.		

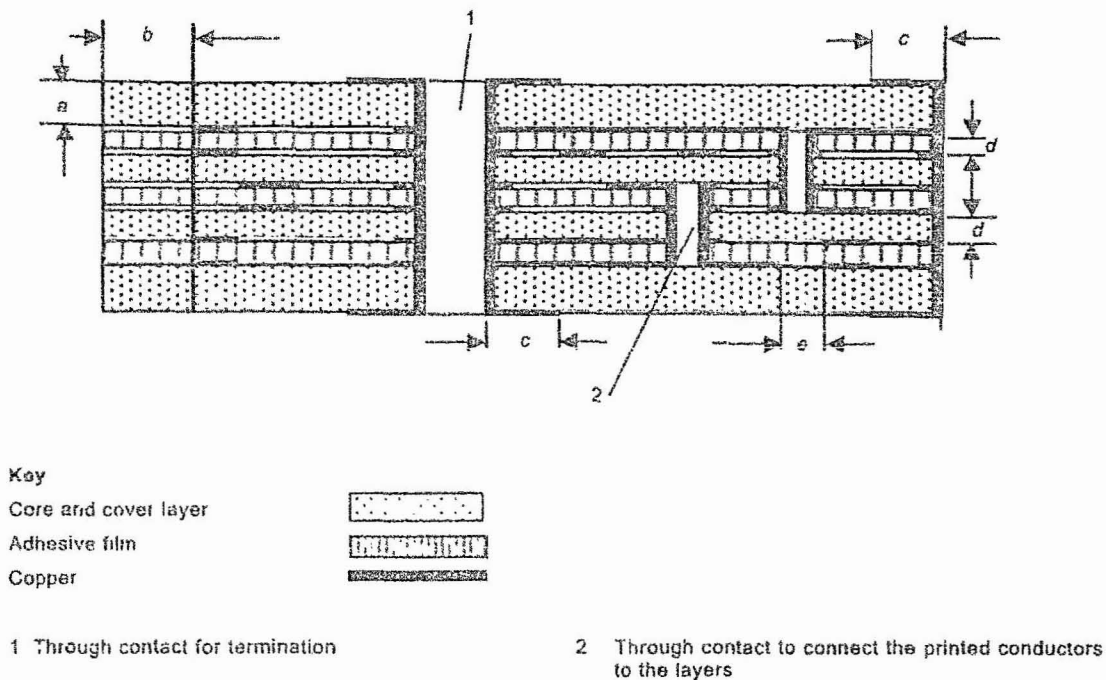


Figure 4 – Minimum distances for multi-layer printed wiring boards

7.3 Switching contacts

Switching contacts shall be provided with an additional enclosure before encapsulation. This additional enclosure shall be made of inorganic material if the switched current exceeds $\frac{2}{3}$ of the rated current specified by the manufacturer of the component or if the current exceeds 6 A.

7.4 External connections

With hard compounds, the sleeving of the connection cable shall be protected against damage by suitable methods. If the entry takes the form of a cable that is permanently connected to the encapsulation "mD" apparatus, the pull test shall be carried out according to 8.2.5.

7.5 Protection of bare live parts

Bare live parts that pass through the surface of the compound shall be protected by another type of protection listed in IEC 61241-0.

7.6 Cells and batteries

7.6.1 General

When evaluating battery control arrangements with respect to the potential evolution of gas the full range of operating temperatures, internal resistance and voltage capability shall be considered. It shall be assumed that batteries can become unbalanced but cells with negligible resistance or voltage capability need not be taken into account.

For level of protection "maD" only batteries complying with IEC 61241-11 are permitted.

7.6.2 Prevention of gassing

Electrochemical systems that can release gas during normal operation are not permitted. If the release of gas in the event of a fault cannot be precluded, the gassing shall be minimised by a safety device in accordance with 7.6.9. With secondary cells the safety device shall be effective not only during charging, but also during discharging. This also applies for charging outside the hazardous area.

In particular,

- a) vented cells shall not be used;
- b) sealed cells with "regulating valves" shall not be used;
- c) gas-tight cells that, within the range of the ambient temperature of the electric apparatus, do not release gas under any operating or fault conditions may be used without a safety device in accordance with 7.6.9;
- d) gas-tight cells that do not fulfil the requirements of 7.6.2 c) shall have a safety device in accordance with 7.6.9.

7.6.3 Permissible electro-chemical systems

The requirements of this subclause shall replace 22.3 of IEC 61241-0.

Only systems shall be used where sufficient experience has shown that they do not release gas during operation. In general only the batteries listed in Tables 6 and 7 are known to meet these requirements.

Table 6 – Permissible primary cells

IEC 60086-1 type	Positive electrode	Electrolyte	Negative electrode	Rated voltage V	Maximum no-load voltage
-	Manganese dioxide	Ammonium chloride	Zinc	1,50	1,73
A	Oxygen	Ammonium chloride	Zinc	1,40	1,55
B	Carbon fluoride	Organic	Lithium	3,00	3,70
C	Manganese dioxide	Organic	Lithium	3,00	3,70
L	Manganese dioxide	Alkali metal hydroxide	Zinc	1,50	1,65
P	Oxygen	Alkali metal hydroxide	Zinc	1,40	1,68
S	Silver oxide	Alkali metal hydroxide	Zinc	1,55	1,63
T	Silver oxide	Alkali metal hydroxide	Zinc	1,55	1,87

Table 7 – Permissible secondary cells

IEC type	Type	Electrolyte	Rated voltage V	Maximum no-load voltage V
Type K IEC 60285 IEC 60622 IEC 61150	Nickel-cadmium	Potassium/Sodium solution	1,20	1,55
IEC 61436	Nickel-metal-hydride	Potassium solution	1,20	1,50
IEC 61960-1	Lithium	Organic salts	3,60	^a
^a Data in preparation.				

7.6.4 Protection against inadmissible temperatures and damage to the cells

Batteries under worst case load shall comply with either a) or b):

- a) in normal service the surface temperature of the cells shall not exceed either the temperature specified by the manufacturer of the cells or batteries or 80 °C at the maximum ambient temperature of the apparatus, and the maximum charging and discharging current shall not exceed the safe value specified by the manufacturer, or
- b) they shall be provided with a safety device in accordance with 7.6.5 to 7.6.9 to prevent unacceptable overheating or gassing inside the encapsulation.

7.6.5 Reverse current

Where there is another voltage source in the same enclosure, the encapsulated battery and its associated circuits shall be protected against charging by other than the circuit specifically designed to do so. For example, by separating the battery and its associated circuits from all other voltage source(s) inside the enclosure, using the clearance distances specified in Table 1 for the highest voltage capable of causing the reverse current.

7.6.6 Current limitation

The maximum surface temperature rating shall be determined using the highest discharge current permitted by the maximum load specified by the apparatus manufacturer or by the protective device, see 7.7, for example 1,7 x rating of the fuse, or at short circuit if neither a load nor a protective device is specified.

A resistor, a current limiting device or a fuse according to IEC 60127 or an equivalent standard, may be used to ensure the safe current specified by the manufacturer of the cells or battery is not exceeded. If replaceable fuses are used they shall be marked to show their rating and function.

7.6.7 Protection against the polarity inversion and deep discharge of the cells

When more than 3 cells are used in series, the cell voltage shall be monitored. During discharging, if the voltage falls below the limit value for the cell voltage specified by the manufacturer of the cells or battery, the safety device shall disconnect the cells.

NOTE 1 If several cells are connected in series, cells can change polarity during discharge due to the various capacities of the cells in a battery. These "reversed pole" cells can enter an inadmissible gassing range.

Where a deep discharge protection circuit is installed to prevent reverse polarity charging of cells during discharge, the minimum cut-off voltage shall be that specified by the cell or battery manufacturer. After disconnecting the load, the current shall be no more than the discharge capacity at the 1 000 h rate.

NOTE 2 If too many cells are connected in series, there may be no safe protection due to the tolerances of the individual cell voltages and the deep discharge protection circuit. Generally no more than six cells (in series) should be protected by one deep discharge protection circuit.

7.6.8 Charging of batteries

The charging circuits shall be fully specified as part of the apparatus. The charging system shall be such that the following is satisfied:

- a) with one fault condition of the charging system the charger voltage and current shall not exceed the limits specified by the manufacturer; or

- b) if, during charging, it is possible for the limit values specified by the manufacturer of the cells or battery for the cell voltage or the charging current to be exceeded, a separate safety device in accordance with 7.7 shall be provided to avoid a release of gas and exceeding the manufacturer's maximum rated cell temperature.

7.6.9 Requirements for safety devices for cells and batteries

Where required, the safety devices shall form safety related parts of a control system. It shall be the responsibility of the manufacturer to provide the information necessary to maintain the safety integrity of the control system.

NOTE Safety related parts meeting the requirements of Category 3 of EN 954-1 "Safety of machinery – Safety related parts of control systems – Part 1: General principles for design" would satisfy the above.

7.7 Protective devices

7.7.1 General

Where the encapsulation "mD" apparatus is not able to withstand a single fault for level of protection "mBd" or two faults for level of protection "maD" without exceeding the COT of the encapsulant, or the temperature class, then a protective device shall be provided either external to the apparatus or directly integrated into the apparatus.

The purpose of the protective devices is the safe technical limitation of an inadmissible heat rise in encapsulation "mD" apparatus. The protective devices shall be capable of interrupting the maximum fault current of the circuit in which they are installed. The rated voltage of the protective device shall at least correspond to the working voltage

Where the encapsulation contains a cell or battery and a safety device is provided to prevent excessive overheating (see 7.6.6), the safety device can also be considered as a protective device, providing it also protects all other components inside the same encapsulation from exceeding the COT or temperature class.

7.7.2 Electrical protective devices

7.7.2.1 General

Fuses shall have a voltage rating not less than that of the circuit and shall have a breaking capacity not less than the fault current of the circuit.

Unless otherwise specified, a fuse shall be assumed to be capable of passing 1,7 x rated current continuously. The time-current characteristic of the fuse shall ensure that the COT of the encapsulant or the maximum surface temperature are not exceeded. The time-current characteristics of the fuses, in accordance with IEC 60127 or ANSI/UL 248-1 shall be stated by the manufacturer of the fuses.

NOTE In the case of electrical supply networks where U_n does not exceed 250 V, the prospective short-circuit fault current is usually 1 500 A.

7.7.2.2 Protective devices that are connected to the encapsulation "mD" apparatus

Where the encapsulation is unable to withstand a single fault, then the encapsulation "mD" apparatus may be connected to separate protective devices. To indicate this special condition of use the apparatus shall be marked "X" in accordance with item 1) of 29.2 of IEC 61241-0.

Where an external protective device or protective circuit is used to control the correct application of voltage, current and power to apparatus with level of protection "maD", the performance of the external protective device or protective circuit shall be equivalent to that for an "ibD" limiting device or circuit in accordance with IEC 61241-11. The permitted levels of voltage, current and power shall be determined by the thermal characteristics of the encapsulated apparatus and not by the requirements for the intrinsic safety.

7.7.3 Thermal protective devices

The requirements of 6.2 shall apply to thermal protective devices. Thermal protection devices shall be used to protect the encapsulation from damage caused by local heating, for example, by faulty components or from exceeding the maximum surface temperature.

Only non self-resettable thermal protective devices shall be used. These devices have no provision for being reset and open a circuit permanently after being exposed to a temperature higher than their rating for a given maximum period. Adequate thermal connection shall be achieved between the monitored component and the thermal protective device. The switching capability of the device shall be defined and shall be not less than the maximum possible load of the circuit.

NOTE Resettable devices may be used for functional reasons. If these devices are used they should operate at temperatures lower than the operating temperature of the thermal protective device.

7.7.4 Built-in protective devices

Protective devices integral with the encapsulation "mD" apparatus shall be of the enclosed type such that no compound can enter during the encapsulation process.

The suitability of the protective device for the intended purpose can be confirmed either by

- a) a declaration by the manufacturer; or
- b) testing of samples.

NOTE Devices in glass, plastic, ceramic or otherwise sealed are regarded as enclosed types.

8 Type tests

8.1 Tests on the compound – water absorption test

The test shall be carried out only on samples of the compound(s) which are intended to be used in a moist environment during operation of the encapsulated electrical apparatus.

Three dry samples, see ISO 62, of the compound(s) shall be tested. The samples shall be circular with a diameter of $50 \text{ mm} \pm 1 \text{ mm}$ and a thickness of $3 \text{ mm} \pm 0,2 \text{ mm}$. The samples shall be weighed then immersed for 24 h in tap water, at a temperature of $23 \text{ °C} \pm 2\text{K}$. They shall then be taken out of the water, wiped dry and weighed again. The increase in mass shall not exceed 1 %.

8.2 Tests on the apparatus

8.2.1 Test sequence

The test sequence and number of samples are given in Annex B.

8.2.2 - Maximum temperature

A sample of encapsulation "mD" apparatus shall be subjected to a type test to ensure that

- the temperature limits specified in 6.1 are not exceeded in normal operation;
- the maximum surface temperature is not exceeded under fault conditions as defined in 7.2.1.

For encapsulation "mD" apparatus without an external load, the test shall be carried out in accordance with 23.4.4.1 of IEC 61241-0 taking into account the supply specification given in 4.5. For encapsulation "mD" apparatus with an external load, the test shall be carried out by adjusting the current to the highest value which does not cause the protective device to operate.

The final temperature shall be considered to be reached when the rate of rise does not exceed 2 K/h.

8.2.3 Thermal endurance test

8.2.3.1 Thermal endurance to heat

The test shall be carried out in accordance with 23.4.6.3 of IEC 61241-0.

The temperature to be used for the test shall be either

- a) the maximum surface temperature of the test sample plus 20 K, see 8.2.2; or
- b) the maximum temperature at the component surface in the compound, see 6.3.2, plus at least 20 K.

If a) is used, then the test sample shall be subjected to the endurance to heat and thermal cycling tests, see 8.2.3.3; in the case of b) the thermal cycling test is not required.

8.2.3.2 Thermal endurance to cold

The test shall be carried out in accordance with 23.4.6.4 of IEC 61241-0.

8.2.3.3 Thermal cycling test

The sample shall be fitted with one or more temperature sensors placed in the compound at the hottest places. If the sample contains windings, the temperature may be measured by the change of electrical resistance of these windings.

NOTE The following test procedure is also shown as a diagram in Annex C.

The test shall be started with the electrical power to the sample switched off. The sample shall be at a temperature of $21\text{ }^{\circ}\text{C} \pm 2\text{ K}$.

The sample shall then be conditioned at $(T_{a\text{ max}} + 10)\text{ }^{\circ}\text{C} \pm 2\text{ K}$, where $T_{a\text{ max}}$ is the specified maximum ambient temperature in service, until the difference between the inside and outside temperatures of the sample is less than 2 K. The sample shall then be energized according to the supply specifications of 4.5 at a voltage which gives the most unfavourable condition unless the sample has one or more internal thermal protective devices. In this case, the sample shall be energized so as to produce a temperature at the non-resettable thermal protective device within 2 K of the highest trip temperature of the device. Internal protective devices may be bridged for test purposes.

The internal temperature change shall be observed until a stable temperature distribution is reached. This is when the gradient of the internal temperature has become less than 2 K/h.

The internal temperature shall not exceed the specified continuous operating temperature of the compound.

The sample shall be de-energized, removed from the $(T_{a \text{ max}} + 10)^\circ\text{C}$ environment and allowed to cool to $21^\circ\text{C} \pm 2 \text{ K}$. The sample shall then be conditioned at $(T_{a \text{ min}} - 5)^\circ\text{C} \pm 2 \text{ K}$, where

$T_{a \text{ min}}$ is the specified minimum ambient temperature, until the temperature difference between the inside and the outside of the sample is less than 2 K.

The sample shall then be energized according to the supply specifications of 4.5, at a voltage which gives the most unfavourable condition of the electrical apparatus.

The internal temperature change shall be observed until a stable temperature distribution is reached; this is when the gradient of the internal temperature has become less than 2 K/h.

The sample shall then be de-energized, and allowed to cool to $(T_{a \text{ min}} - 5)^\circ\text{C} \pm 2 \text{ K}$. The minimum duration for cooling shall be 30 min unless the 2 K temperature differential criterion requires a longer time.

The power shall again be switched on and the energizing and de-energizing cycle repeated. In all, three complete cycles shall be carried out before the sample is removed from the $(T_{a \text{ min}} - 5)^\circ\text{C}$ environment and allowed to reheat at room temperature.

8.2.3.4 Acceptance criteria

After each test the sample shall be subjected to a visual inspection. No visible damage to the compound that could impair the type of protection shall be evident, for example cracks in the compound, exposure of encapsulated parts, failure of adhesion, impermissible shrinkage, discoloration, swelling, decomposition or softening. A discoloration on the surface of the compound is permissible (for example oxidation in the case of epoxy resin).

In addition, the function of any electrical protective device on which safety depends shall be verified as having operated within its stated parameters.

8.2.4 Dielectric strength test

8.2.4.1 Test procedure

The test shall be carried out on one of the following arrangements of circuits as applicable:

- a) between galvanically isolated circuits that are accessible from the exterior;
- b) between each circuit that is accessible from the exterior and all earthed parts;
- c) between each circuit that is accessible from the exterior and the surface of the compound or the plastic enclosure, that, if necessary, can be clad with a conductive foil.

For arrangement a), the voltage U to be used shall be the sum of the rated voltages of the two circuits being tested, and for arrangements b) and c) the voltage U to be used shall be the rated voltage of the circuit being tested.

The test voltage shall be 500 V r.m.s. for apparatus where the sum of the supply voltages does not exceed 90 V peak. If the supply voltage exceeds 90 V peak the test voltage shall be $2U + 1\,000\text{ V}$, with a minimum of 1 500 V a.c. at 48 Hz to 62 Hz. Where an alternating test voltage would damage electronic components in the encapsulation, the test voltage shall be $2U + 1\,400\text{ V d.c.}$ with a minimum of 2 100 V d.c.

The test voltage shall be increased steadily within a period of not less than 10 s until it reaches the prescribed value, and it shall then be maintained for at least 60 s.

NOTE In the case of apparatus that, for electro-magnetic compatibility reasons, contain components connected to the enclosure for the suppression of interference pulses and which could be damaged during the tests, a partial discharge test may be carried out.

8.2.4.2 Acceptance criteria

The test shall be deemed as passed if no breakdown or arcing occurs during testing.

8.2.5 Cable pull test

8.2.5.1 General

This test is not performed on Ex Components.

8.2.5.2 Test procedure

The test shall be carried out on one sample, previously unstressed and at $21\text{ }^{\circ}\text{C} \pm 2\text{ K}$.

A further test sample shall be subjected to the cable pull test after conditioning according to 8.2.3.1 at the maximum temperature at the cable entry point.

The tensile force (in Newton) applied shall either be 20 times the value in millimetres of the diameter of the cable or 5 times the weight of the encapsulation "mD" apparatus, whichever is the lower value. This value can be reduced to 25 % of the required value in the case of permanent installations. The minimum tensile force shall be 1 N and the minimum duration shall be 1 h. The force shall be applied in the least favourable direction.

8.2.5.3 Acceptance criteria

Visible displacement of the cable, which affects the type of protection, shall not be observed. After testing, the sample shall be subjected to a visual inspection. No damage to the compound or cable that could impair the type of protection shall be observed, for example, cracks in the compound, exposure of the encapsulated components or failure of adhesion.

8.2.6 Pressure test

8.2.6.1 Test procedure

For level of protection "maD" with any individual free spaces between 1 cm^3 and 10 cm^3 and level of protection "mbD" with any individual free spaces between 10 cm^3 and 100 cm^3 , a test sample with a pressure connection shall be prepared. Where there is more than one free space of a size requiring testing, the pressure shall be carried out simultaneously in all those free spaces.

The pressure test shall be carried out on a sample that has already been submitted to the thermal endurance tests.

The test shall be carried out with a pressure as shown in Table 8 applied for at least 10 s.

Table 8 – Test pressure

Minimum ambient temperature	Test pressure bar
$\geq -20\text{ }^{\circ}\text{C}$ ^a	1 000
$-30\text{ }^{\circ}\text{C}$	1 370
$-40\text{ }^{\circ}\text{C}$	1 450
$-50\text{ }^{\circ}\text{C}$	1 530
$-60\text{ }^{\circ}\text{C}$	1 620
^a This covers apparatus designed for the standard ambient temperature range specified in IEC 61241-0	

8.2.6.2 Acceptance criteria

After testing, the sample shall be subjected to a visual inspection and no damage to the compound that could impair the type of protection shall be observed, for example, cracks in the compound, exposure of the encapsulated components or failure of adhesion.

9 Routine verifications and tests

9.1 Visual inspections

Each piece of encapsulation "mD" apparatus shall be subjected to a visual inspection. No damage shall be evident, such as cracks in the compound, exposure of the encapsulated parts, flaking, inadmissible shrinkage, swelling, decomposition, failure in adhesion or softening.

9.2 Dielectric strength test

The dielectric strength test shall be used to test the isolation of circuits from each other and from their environment. The test shall be carried out applying the voltage levels given in 8.2.4.

The test voltage shall be applied for at least 1 s.

Alternatively, 1,2 times the test voltage may be applied and maintained for at least 100 ms.

NOTE In some cases, the actual test period could be significantly longer than 100 ms as a sample with a large distributed capacitance may take some additional time to reach the actual test voltage.

The test shall be deemed as passed if no breakdown or arcing occurs during testing.

Contrary to the above the dielectric strength test for batteries shall be carried out in accordance with 6.6.2 of IEC 60079-7.

10 Marking

In addition to the requirements of IEC 61241-0 the marking shall include

- the rated voltage,
- the rated current or rated power (for apparatus at other than unity power factor both values shall be marked),
- the prospective short-circuit current of the external electric supply source if different from 1 500 A,
- other information necessary for safe operation of the particular apparatus.

Annex A
(informative)

Basic requirements for compounds for encapsulation “mD” apparatus

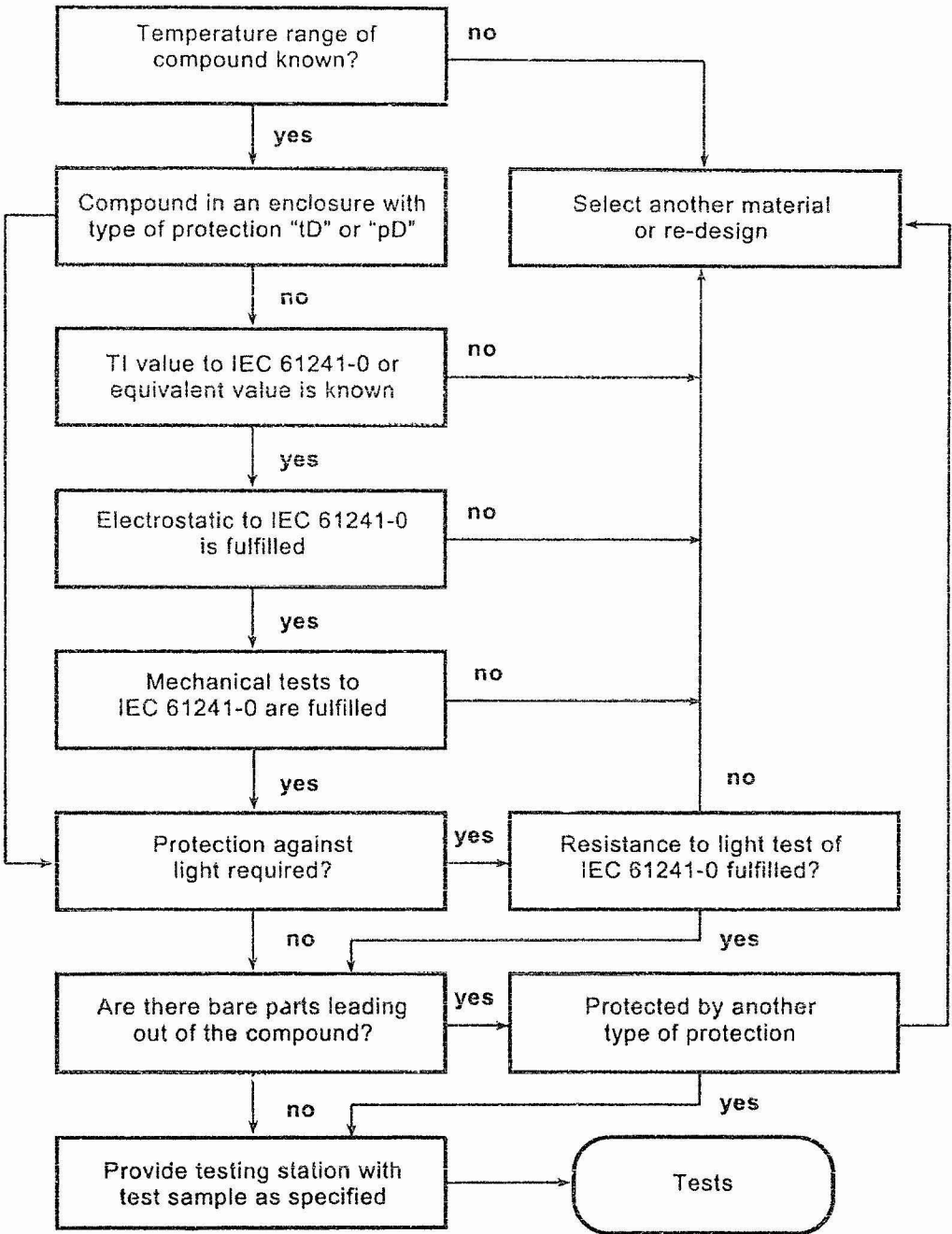


Figure A.1 – Basic requirements for compounds for encapsulation “mD” apparatus

Annex B
(normative)

Allocation of test samples

Table B.1 – Allocation of test samples

Standard tests		Additional tests	
Sample 1	Sample 2	Sample 3	Sample 4
Determination of limiting temperature in accordance with 6.3			
		Cable pull test in accordance with 8.2.5 at room temperature on a new sample (if required)	Storage at the maximal temperature measured at the cable entry for a time in accordance with 8.2.3.3 (if required)
Thermal endurance to heat in accordance with 8.2.3.1	Thermal endurance to heat in accordance with 8.2.3.1		
Thermal endurance to cold in accordance with 8.2.3.2	Thermal endurance to cold in accordance with 8.2.3.2		
Thermal cycling testing in accordance with 8.2.3.3 (if required)	Thermal cycling test in accordance with 8.2.3.3 (if required)		Cable pull test in accordance with 8.2.5
Electric strength test in accordance with 8.2.4	Electric strength test in accordance with 8.2.4		
Pressure test in accordance with 8.2.6 (if required)	Pressure test in accordance with 8.2.6 (if required)		
Mechanical tests in accordance with IEC 61241-0 (if required)	Mechanical tests in accordance with IEC 61241-0 (if required)		

NOTE The tests are carried out in the order they appear in each column.

Diagram 1
Voltage on
the sample

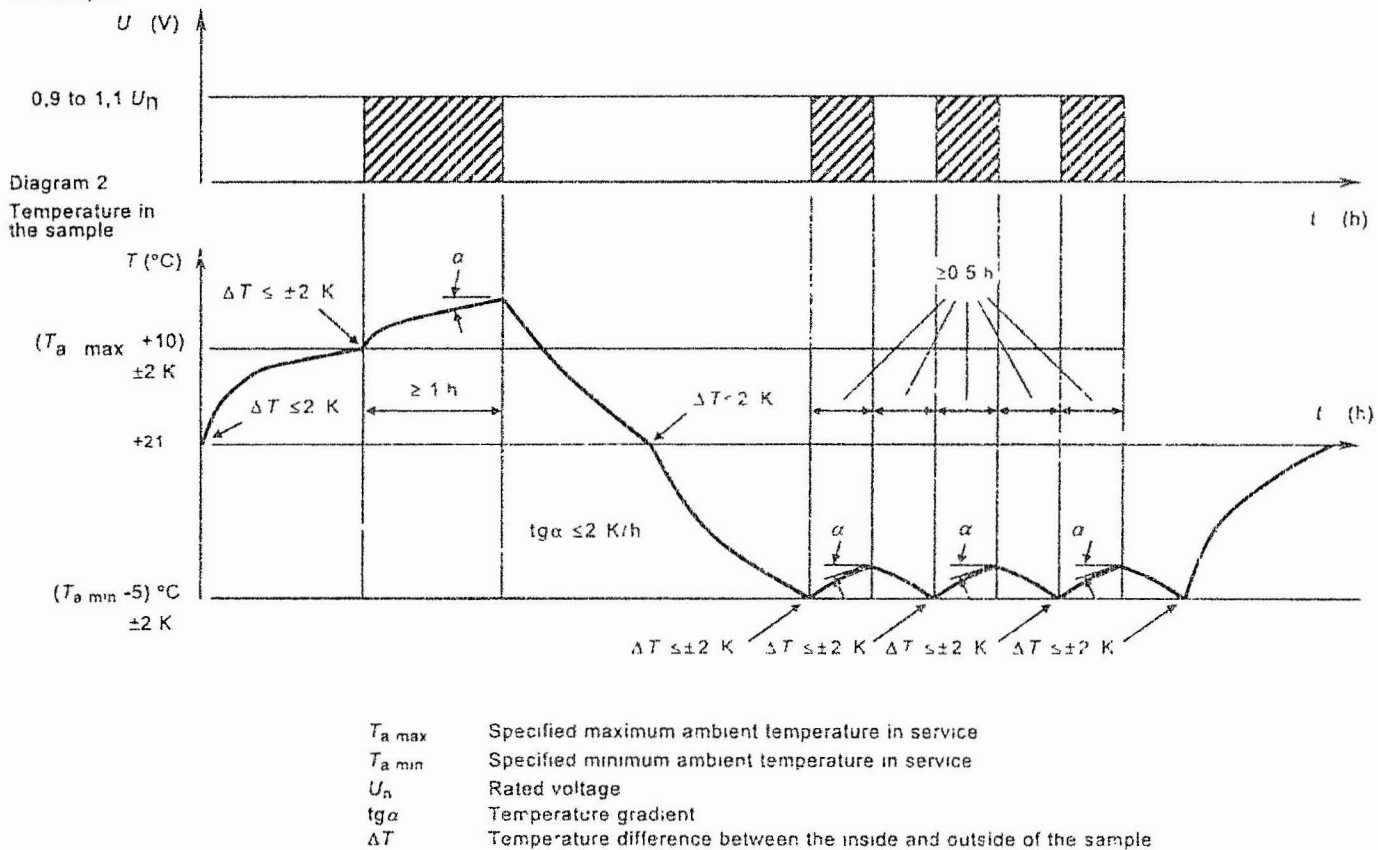


Figure C.1 – Test procedure during thermal cycling test

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
IEC 60243-1 Electrical strength of insulating materials — Test methods — Part 1: Tests at power frequencies	IS 2584 : 1963 Method of test for electric strength of solid insulating materials at power frequencies	Technically Equivalent
IEC 60664-1 : 1992 Insulation co-ordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests	IS 15382 (Part 1) : 2003 Insulation coordination for equipment within low-voltage systems: Part 1 Principles, requirements and tests	Identical
IEC 60691 Thermal links — Requirements and application guide	IS/IEC Pub 691 : 1993 Thermal links — Requirements and application guide (<i>first revision</i>)	Technically Equivalent
IEC 61241-0 Electrical apparatus for use in the presence of combustible dust — Part 0: General requirements	IS/IEC 61241-0 : 2004 Electrical apparatus for use in the presence of combustible dust: Part 0 General requirements	do
IEC 61241-1 Electrical apparatus for use in the presence of combustible dust — Part 1: Protection by enclosures "tD"	IS/IEC 61241-1 : 2004 Electrical apparatus for use in the presence of combustible dust: Part 1 Protection by enclosures "tD"	do
IEC 61241-11 Electrical apparatus for use in the presence of combustible dust — Part 11: Protection by intrinsic safety "ID"	IS/IEC 61241-11 : 2005 Electrical apparatus for use in the presence of combustible dust: Part 11 Protection by intrinsic safety "ID"	do
IEC 61558-2-6 Safety of power transformers, power supply units and similar — Part 2: Particular requirements for safety isolating transformers for general use	IS/IEC 61558-2-6 : 1997 Safety of power transformers, power supply units and similar: Part 2 Particular requirements, Section 6 Safety isolating transformers for general use	do
ISO 62 : 1980 Plastics — Determination of water absorption	IS 13360 (Part 8/ Sec 1) : 1997 Plastics — Methods of testing: Part 8 Permanence/Chemical properties, Section 1 Determination of water absorption	do

The technical committee has reviewed the provisions of the following International Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

<i>International Standard</i>	<i>Title</i>
IEC 60285 : 1993	Alkaline secondary cells and batteries — Sealed nickel — Cadmium cylindrical rechargeable single cells
IEC 60622	Secondary cells and batteries containing alkaline or other non-acid electrolytes — Sealed nickel-cadmium prismatic rechargeable single cells
IEC 61150	Alkaline secondary cells and batteries — Sealed nickel cadmium rechargeable monobloc batteries in button cell design

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Amendments Issued Since Publication

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